Automated Trajectory Design Using Resonant Dynamics

Completed Technology Project (2011 - 2015)

Project Introduction

The goal of this project is to map spacecraft transit routes through resonances. This will enable automated, on-board trajectory redesigns to allow for autonomous and safer missions. In particular, this will benefit high priority NASA missions such as a Europa and Outer Planet Moon orbiters as well as Manned Missions to small bodies as a stepping stone to Mars. Current missions and future mission concepts such as Dawn and the various Europa orbiter proposals have indicated that resonant regions near small bodies and planetary moons exhibit fast acting orbital instabilities. This may prevent mission designers on Earth from having time to issue new commands. The availability of autonomous targeting methods related to these dynamics would provide a systematic means for taking advantage of resonant regions and mitigate the associated risk. While spacecraft will not have the time or computational power to completely plan new trajectories from scratch, there is another method. We propose to create a database of key routes that will be organized using the language of symbolic dynamics. Advances in libration point dynamics have shown that transit orbits can be classified in this way and our intent is to extend this to other resonant regions. Finite automata and fast search techniques will be used to select a seed trajectory that accomplishes the necessary goal. This will then be differentially corrected to the exact conditions to yield an accurate path that will direct the spacecraft.

Anticipated Benefits

This will enable automated, on-board trajectory redesigns to allow for autonomous and safer missions. In particular, this will benefit high priority NASA missions such as a Europa and Outer Planet Moon orbiters as well as Manned Missions to small bodies as a stepping stone to Mars.

Project Image Automated Trajectory Design Using Resonant Dynamics

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Organizational Responsibility

Responsible Mission Directorate:

Space Technology Mission Directorate (STMD)

Responsible Program:

Space Technology Research Grants

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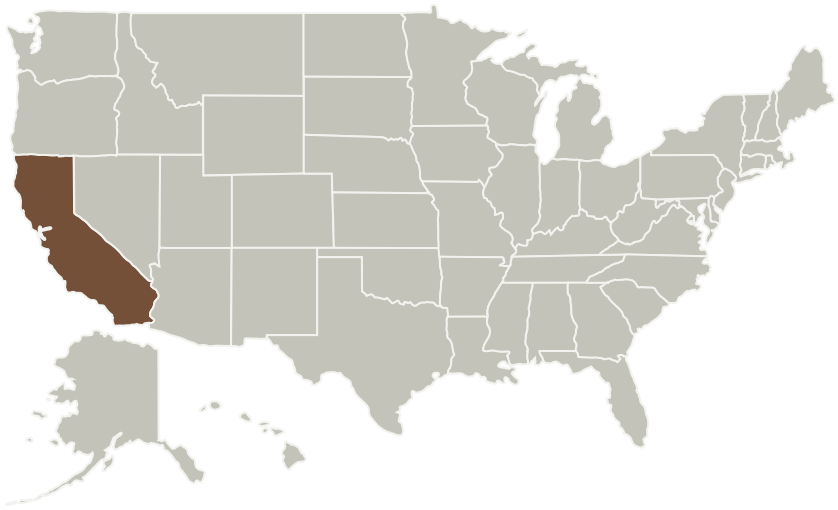
Primary U.S. Work Locations and Key Partners



Organizations Performing Work	Role	Type	Location
University of California-Berkeley(Berkeley)	Supporting Organization	Academia	Berkeley, California
University of California-Irvine	Supporting Organization	Academia	Irvine, California

Primary U.S. Work Locations
California

Project Management

Program Director:
Claudia M Meyer

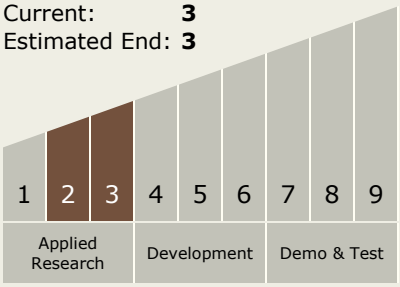
Program Manager:
Hung D Nguyen

Principal Investigator:
Kenneth Mease

Co-Investigator:
Eric Trumbauer

Technology Maturity (TRL)

Start: **2**
Current: **3**
Estimated End: **3**



Technology Areas

Primary:

- TX17 Guidance, Navigation, and Control (GN&C)
  - TX17.5 GN&C Systems Engineering Technologies
    - TX17.5.5 Vehicle Flight Dynamics and Mission Design Tools/Techniques

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Images

4243-1363114106810.jpg
Project Image Automated Trajectory Design Using Resonant Dynamics
(https://techport.nasa.gov/image/1717)

Project Website:

https://www.nasa.gov/directorates/spacetech/home/index.html